CONTROL ID: 2190955

TITLE: Loss of Water in Early Earth's Atmosphere and Its Effects on Habitability

ABSTRACT BODY:

Abstract Body: The short wavelength emission from the Sun has a profound impact on the Earth’s atmosphere. High energy photons ionize the atmosphere and produce photoelectrons. This process provides a major contribution to the acceleration of atmospheric ions due to the vertical separation of ions and electrons, and the formation of the resulting ambipolar electric field. Observations and theory suggest that even a relatively small fraction of super-thermal electrons (photoelectrons) produced due to photoionization can drive the ”polar wind” that is responsible for the transport of ionospheric constituents to the Earth’s magnetosphere.

The young Sun was a magnetically active star generating powerful radiative output from its chromosphere, transition region and corona which was a few hundred times greater than that observed today. What effects would the photoionization processes due to the X-ray-UV solar flux from early Sun have on the loss of water from the early Earth?

We use the Fokker-Plank code coupled with 1D hydrodynamic code to model the effect of intensive short-wavelength (X-rays to UV band) emission from the young Sun (3.8 and 4.4 Ga) on Earth's atmosphere. Our simulations include the photoionization processes of the Earth’s atmosphere forming a population of photoelectrons (E<600 eV), the kinetic effects of their propagation associated and their contribution in ionosphere – magnetosphere energy redistribution. Our coupled simulations show that the ambipolar electric field can drag atmospheric ions of oxygen and hydrogen to the magnetosphere and produce significant mass loss that can affect the loss of water from the early Earth in the first half a billion years. This process became less efficient in the next 0.2-0.3 Ga that could have provided a window of opportunity for origin of life.

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